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INFORMATION BUREAU.

Missouri stands ninth among the states in the value of its mineral output; has a greater variety of commercial minerals than any state in the Mississippi Valley; stands first in the production of lead, zinc; second in barytes; is one of the two chief centers in the manufacture of fire brick; is an important manufacturer of lime and Portland cement; has mines producing the semi-rare metals cobalt, nickel and tungsten; is an important producer of pyrites, used in the manufacture of sulphuric acid; ships marble throughout the United States for interior decorative purposes, and has large deposits of coal and iron as yet undeveloped.

These various mineral resources occur in different geological formations and under very different geological conditions. A knowledge of these features is of the greatest help in prospecting and development work.

The Missouri Bureau of Geology and Mines, or Geological Survey, is maintained by the State for the purpose of assisting in the development of these resources. The detailed reports of the department describe the nature and extent of the various commercial resources and are distributed to investors and citizens without cost other than transportation. Samples of Missouri ores and rocks sent the Bureau are examined and their probable value determined.

The Department is at your service.

H. A. BUEHLER, State Geologist
Rolla, Missouri

MINERAL RESOURCES OF MISSOURI IN 1898 AND 1916.

Commodity	1898	1916
Zinc Ore	$2,927,321	$24,228,596
Lead Ore	3,011,055	24,172,965
Coal	3,148,826	9,044,505
Clay Products	3,256,207	7,634,559
Cement	None	6,333,567
Building Stone	437,874	2,278,742
Sand and Gravel	No data	877,634
Lime	297,401	956,300
Clay (mined)	No data	988,884
Barytes	61,875	365,111
Copper	None	95,005
Mineral Waters	59,341	109,814
Tripoli	None	99,248
Iron Ores	123,345	116,484
Silver	None	85,178
Miscellaneous— (Tungsten, Cobalt, Nickel, Pottery, Pyrites, Oil, Gas, Paint)	No data	1,178,830
Totals	$13,323,245	$78,558,422

Total Mineral Production.

Year	*Value*
1913	$47,760,584
1914	43,585,667
1915	59,821,032
1916	78,558,422

MINERAL RESOURCES OF MISSOURI

ASPHALT.

Extensive exposures of asphaltic sandstone occur in Barton, Vernon, Bates, Cass, Ray, Lafayette, Cedar, and other western Missouri counties. The sandstones occur in the Cherokee formation of the Lower Coal Measures.

The asphalt which usually contains considerable oil is a residuum from the evaporation of crude petroleum formerly contained in these beds. Analyses of samples of the sandstone show from 5 to 20 per cent soluble material.

It is believed that with proper treatment the sandstone might be used as a road metal. At Liberal, Barton County, this sandstone has been quarried for curbing and flagging.

BARYTES.

Production in 1916 was 58,407 tons, valued at $365,111.

Missouri ranks second only to Georgia in the production of barytes, and until this year was the leading producer of this mineral. The ore produced is high grade and brings the top price on the market. The output is obtained chiefly from Washington, Cole, Franklin, Jefferson, Miller, Morgan, Texas and St. Francois counties. Washington county produces three-fourths of the State total.

This mineral which is commonly called "tiff" or "heavy spar" occurs principally in the surface clays and is mined from shallow pits. In Jefferson and Franklin counties it is found in fissures associated with lead ore.

Mills for refining the crude mineral are located at St. Louis and Mineral Point. Barytes is used largely in the manufacture of mixed paints; as a cloth and paper filler; and in the manufacture of rubber, lithophone, wall paper, chemicals, etc.

CLAY AND CLAY PRODUCTS.

Production in 1916 valued at $8,623,443.

Missouri is one of the most important clay working states, ranking eighth in the value of clay products. The state manufactures every class of brick and tile, standing second in the manufacture of fire brick, sewer pipe, and enameled brick,

Barytes Ready for Shipment, Washington County.

Fire Clay Pit, Fulton, Callaway County.

fifth in fancy brick, sixth in front brick and terra cotta, seventh in drain tile and ninth in vitrified brick and blocks.

No state has a greater variety of valuable clays. The center of the fire clay industry is in St. Louis, Callaway, and Audrain counties where a high grade plastic fire clay is obtained from the Pennsylvanian formations. Non-plastic flint fire clay is obtained largely from Warren, Montgomery, Gasconade, Crawford, Franklin, Maries, Phelps, Dent and adjoining counties. Associated with these fire clays occurs some high alumina material, analyzing as high as 75 per cent alumina. This material has only been produced during the past two years.

The Coal Measures contain an inexhaustible supply of shale suitable for the manufacture of brick, and fire clays are associated with the coal seams. The loess clay found along the Missouri and Mississippi rivers is extensively used for common brick.

White kaolin occurs in Cape Girardeau and Bollinger counties. Sewer pipe is manufactured chiefly in St. Louis and at Brownington, Henry County.

Every county in the state contains clay deposits that can be utilized.

COAL.

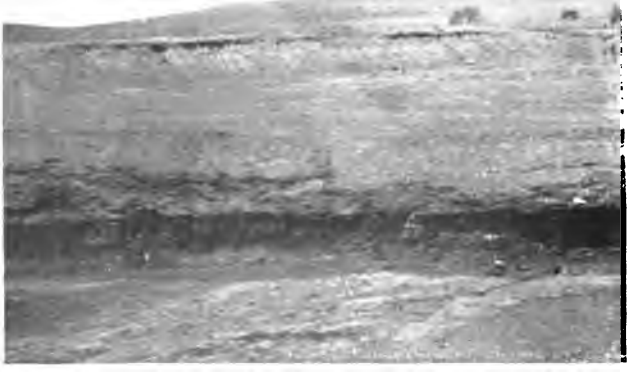
Production in 1916 was 4,742,146 tons; valued at $9,044,505.

The Coal Measures underlie about 25,000 square miles of northern and western Missouri. They contain a number of commercial coal beds varying from 18 inches to 5 feet in thickness. Barton, Lafayette, Macon, Audrain, Ray, Randolph, Henry, Linn, Bates, Vernon, and Platte counties are the chief producing areas. Cannel coal occurs in pockets in Miller, Morgan, Cole, Gasconade and other counties throughout the northern Ozarks. Some of these pockets attain a thickness of 50 to 80 feet but are of small lateral dimensions.

Missouri has a coal reserve estimated at 75,000,000,000 tons, in beds over 14 inches thick. About 150,000,000 tons have been mined. The markets are chiefly western Missouri, Nebraska, and northern Kansas. Missouri coal fields are capable of much greater expansion.

A notable feature of Missouri coal mining industry is the large production from thin seams. Over one-half of the output comes from beds less than 3 feet thick and much of it from beds less

Brick and Tile Plant, St. Louis, Missouri.



Coal Bed, Henry County.

than 25 inches in thickness. From the Lexington seam alone, which averages only 18 to 24 inches, over 1,500,000 tons of coal is produced annually, in Lafayette, Ray and adjoining counties. The Bevier seam, 3 to 6 feet thick, is the thickest persistent coal bed in the state and is mined extensively in Macon, Adair and adjoining counties. Some beds in Bates and Henry counties are much thicker than the Bevier locally, but these beds are not of the same persistent character and their commercial importance is restricted to smaller areas.

The coal is obtained largely from shaft mines though much of it comes from drifts driven on the outcrop and from strip pits. In Barton County giant steam shovels are used in stripping and their success has placed this county foremost among the producing counties. These shovels remove profitably 20 to 30 feet or more of shale overburden, to expose a coal bed only 22 to 30 inches. This type of mining is now being extended into Vernon Bates, and St. Clair counties where successful development is anticipated.

NICKEL AND COBALT.

Extensive deposits of the semi-rare metals cobalt and nickel occur near Fredericktown and Mine LaMotte in Madison County. Large ore bodies have been developed by the Missouri Cobalt Company, the Mine LaMotte Company and on the Schulty tract south of Fredericktown. At present these are the only commercial deposits being operated in the United States.

The ore is found at the contact of the granite with the Bonne Terre dolomite and LaMotte sandstone. It consists of a complex mixture of lead copper, cobalt, nickel, iron sulphides which runs about 2 per cent lead, 2 per cent copper, and one per cent each of cobalt and nickel. Similar geologic conditions extend over a large area but development has not progressed beyond the present productive district.

Small quantities of the same sulphides are recovered in concentrating the lead ores of the disseminated lead district of St. Francois County.

COPPER.

Production in 1916 valued at $95,005.

Copper in small amount has been produced in Missouri intermittently since 1837. The most

Coal Mine, Randolph County.

Stripping Coal, Barton County Field.

extensive deposits occur near Fredericktown, Madison County, where this metal is found in the complex lead, copper, cobalt-nickel ore mined in that district. The Missouri Cobalt Company is now operating these deposits on a large scale.

Copper deposits in Ste. Genevieve County have been operated intermittently for may years. The chief mines are the Swansea and Cornwal properties about 8 miles southwest of Ste. Genevieve, where the ore occurs in cherty beds of the Jefferson City formation which vary from 18 to 36 inches in thickness.

Throughout the central Ozark region copper carbonates and a small amount of copper sulphide occur associated with the red iron ore deposits. As yet no attempt has been made to develop these copper ores on a commercial scale except at the property of the Copper Mountain Copper Company south of Sullivan, Franklin County where a small copper smelter has been erected and some matte produced from the ores occurring with the iron at that place. At the present time the property is being operated for iron exclusively.

Copper has been found near Eminence in Shannon County at the Slater mine where a shaft has been sunk over 150 feet in the porphyry. Some prospecting and mining has also been done at the Jerktail property north of Eminence and a number of other prospects have been opened in this area. During the past year some copper ore has been shipped from near Racola, Washington County.

FELDSPAR.

Deposits of potash feldspar have been opened in Ste. Genevieve County, where the mineral occurs in irregular veins in the granite rock. Though idle at present three of these deposits have made commercial shipments, the material being used in the manufacture of pottery.

GRANITE.

Production in 1916 was valued at $80,390.

Missouri red granite is unexcelled for richness of color, strength and durability. It is quarried chiefly in Iron, and Madison Counties although the area of granite rocks extends over a number of adjoining counties including Shannon, Reynolds, Carter, Wayne, Washington and St. Francois.

The granite is light to deep red in color, takes a high polish and shows an excellent contrast between

Monument of Missouri Granite.

polished and bush hammered surfaces. Blocks of practically any size can be quarried and dimension stone, free from flaws, can be obtained in unlimited quantities. Several million paving blocks are shipped annually from the quarry centers. The porphyry which occurs in the area of igneous rocks is broken into small blocks by numerous joints and is not suitable for dimension stone.

IRON ORE.

Production in 1916 was valued at $116,484.

Commercial deposits of iron ore occur over a large part of the Ozark region. The area is noted for the variety of these ores which occur in large quantities and have been mined at widely scattered localities.

High grade specular hematite occurs in the porphyry in the Iron Mountain-Pilot Knob region. In the past this area has produced a large tonnage and at one time was one of the most important iron mining centers of the United States.

Both red and specular hematite occurs in Crawford, Phelps, Gasconade, Franklin and adjoining counties in deposits which fill old caves or sinks. This area has been a large producer, the ores usually being obtained thru open pits.

Limonite or brown iron ore occurs chiefly in southeast Missouri though deposits are scattered over the southern Ozark country. It is found chiefly embedded in the surface clay resulting from the decomposition of the rocks of the region. This ore varies from the high grade so called "pipe ore," found extensively in Carter, Wayne, Reynolds and adjoining counties to the low grade cherty limonite produced from the counties bordering the southeast lowlands. A considerable production of high grade ore has come from Christian, Greene, and Dade counties in southwest Missouri.

Three furnaces are in operation at the present time owned by: The Mississippi Valley Iron Company, St. Louis; the Sligo Furnace Company, Sligo; and the Mid Continent Iron Company, Fremont. The last two make charcoal iron.

LEAD ORE.

Production in 1916 was 347,867 tons of concentrate, valued at $24,172,965.

Missouri has the largest lead mines in the world and outranks every other state or foreign country

Granite Quarry, Iron County.

Cherry Valley, Iron Mine, Crawford County.

in the production of lead. Almost 90 per cent of the output is obtained from the lead Belt in St. Francois and Madison counties in southeast Missouri. The mines center around Flat River, Bonne Terre, Leadwood, Mine LaMotte, and Fredericktown. The district is equipped with finest mining and milling machinery, the mills having a capacity of from 2,000 to 5,000 tons per day. The ores, which occur at depths ranging up to 500 feet are large blanket like deposits which vary up to 100 feet in thickness.

About 10 per cent of the lead output is obtained from the southwest Missouri district in Jasper, Lawrence, Newton, Greene, and adjoining counties. The mines of this district however produce zinc chiefly with which ore the lead occurs.

In Jefferson, Franklin and Washington counties lead ore is found in shallow runs and fissure deposits, usually associated with barite. Throughout most of the Ozark region lead is found in shallow deposits from which shipments are occasionally made. Miller, Cole, Morgan and many other Ozark counties are intermittent producers.

LIME.

Production in 1916 was valued at $956,300.

Missouri stands fourth among the states in the production of lime. Large plants are located at Ash Grove, Peirce City, Sarcoxie, Springfield, Louisiana, Hannibal, Glencoe, Mincke, Kimmswick, Glen Park, Brickey, Ste. Genevieve and Cape Girardeau.

An inexhaustible supply of pure limestone is available from the Burlington, Kimmswick and Spergen formations in the southwest, central and northeast and southeast parts of the state. The plants operated in southwest and northeast Missouri secure the raw material from the Burlington limestone, those near St. Louis and in southeast Missouri other than at Ste. Genevieve use stone from the Kimmswick, while the plants at Ste. Genevieve use oolitic stone from the Spergen formation. All of these formations produce a pure high calcium lime; that from the Burlington and Spergen being pure white while the Kimmswick lime is slightly gray in color and cannot be used for finishing purposes.

Charcoal Ovens, Sligo Iron Furnace, Dent County.

Lead Mill, Elvins, St. Francois County.

LIMESTONE.

Production in 1916 was valued at $1,990,419.

Limestone suitable for structural purposes is widely distributed throughout the state although the chief quarrying districts producing cut stone are at Carthage and Phenix in Jasper and Greene counties. The stone product of these two districts is a white, crystalline stone unexcelled in durability, strength, and uniformity of color. The stone is obtained from the Burlington formation and in addition to being used for the construction of the finest exterior work is manufactured into a fine quality of gray marble equal to any on the market. This marble is now shipped throughout the United States for interior decoration. The new State Capitol, the interior and exterior of which is constructed from the Carthage-Phenix marble stands as a monument to the beauty of this stone.

The Kimmswick formation at Cape Girardeau furnishes an excellent crystalline white limestone that has been used extensively in the local markets. Excellent stone occurs north of Ste. Genevieve in the Spergen formation. These ledges have not been quarried extensively.

Large crushing plants are located in all parts of the state, the output being used for road work, railroad ballast and concrete. At a number of the plants the fine material is pulverized for fertilizer.

CHATS.

Mine tailings, called "chats" derived from the mining of lead and zinc ores in both southeast and southwest Missouri are used extensively in this and adjoining states for road construction, concrete and railroad ballast. The southwest Missouri chats are chiefly chert, the southeast material dolomite.

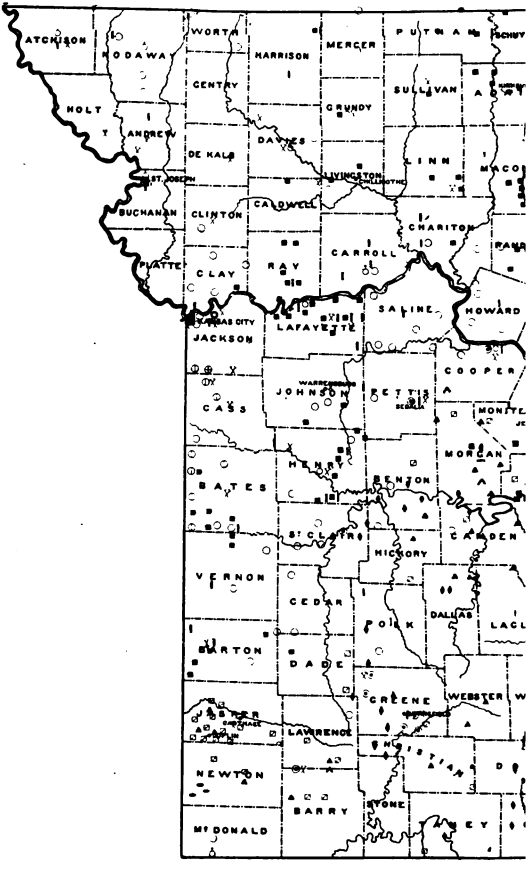
Over 2,000,000 tons are used annually; chiefly in railroad construction.

MINERAL PAINTS.

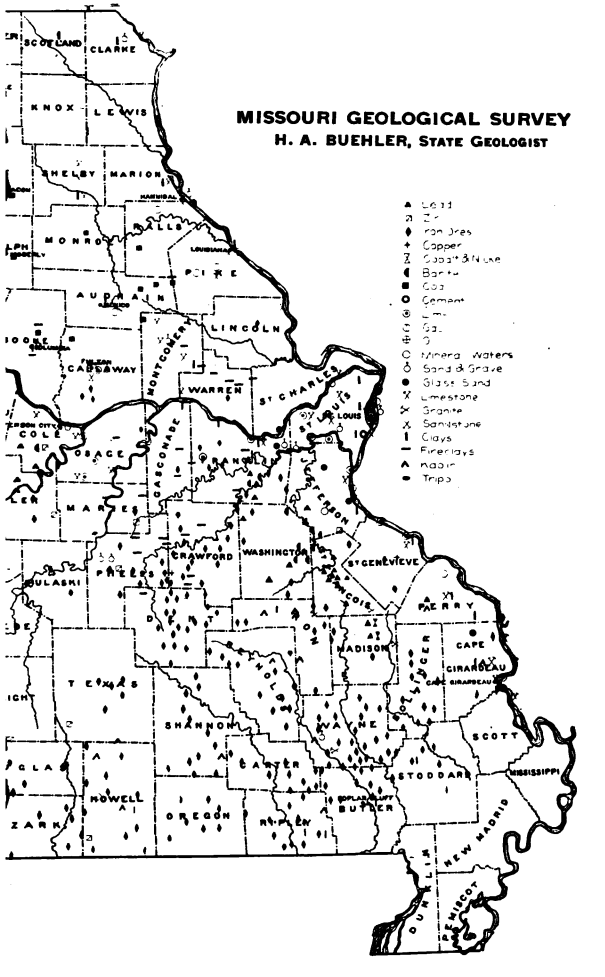
The manufacture of mineral paints is an important industry in Missouri, based upon the mineral resources of the State.

The raw materials are lead, zinc, ferruginous shales, limestone and barytes.

Missouri is the chief producer of sublimed white and blue lead manufactured directly from lead ores.



Map Showing Loca



ion of Mineral Deposits

Lead Smelter, Herculaneum, Jefferson County.

Lime Plant, Ash Grove, Greene County.

Large plants are located at Joplin and St. Louis. White lead is manufactured from pig lead on a large scale in St. Louis.

Lithophone is manufactured by a mixture of barytes and zinc ore. Ground and floated barytes is largely used with zinc oxide and lead in the manufacture of white pigments.

Soft ocherous hematite and brown limonite and ferruginous clays found with the iron ores of the central Ozark region have been utilized in the manufacture of ocher and other cheap mineral fillers. A black pigment known as "formastat" is produced from specular iron ore found near Doe Run. It is used chiefly as a covering for metallic surfaces.

Whiting is manufactured from the white limestone found near St. Louis, Cape Girardeau, and Kissinger.

The paint industry has increased rapidly during the past few years.

MINERAL WATERS.

Production in 1916 was valued at $109,814.

A great variety of mineral waters, suitable for medicinal and table use are secured and marketed from more than 50 springs and wells scattered widely over the state. These, however represent only a few of the many possible sources of such waters. No state in the Middle West has a greater variety of mineral waters or more extensive areas from which they may be produced than Missouri. Chalybeate, Lithia, Muriatic, Sulpho-saline, and Alkaline waters are among its types included and marketed. Clay, Cedar, Pike, Jackson, Jefferson, St. Louis and Saline counties are now the principal centers of production.

The most important and best known group of springs is located at Excelsior Springs in Clay County. Most of the types mentioned above occur here. As a health resort Excelsior Springs is one of the most widely patronized in the country and its waters are reputed to be among the most valuable medicinally. Every effort has been made to promote the mineral water industry along scientific and sanitary lines; efforts which have met with abundant success.

ElDorado Springs also has a wide reputation because of the medicinal properties of its waters and the B. B. Spring at Bowling Green is probably one of the most noted sulphate springs in the Mississippi Valley.

Quarry, Phenix, Greene County.

Stone Mill, Phenix, Greene County.

The Ozark region contains many enormous springs of pure water suitable for municipal supplies. Hahatonka, Greer, Big, Meramec, Bennetts and Round Spring are among the largest and have a daily flow of over 100,000,000 gallons each.

OIL AND GAS.

Both oil and gas have been found in relatively small quantities in a number of wells in the western part of the state. Bates, Cass, Jackson and Platte counties have so far yielded the best results in drilling though in Vernon, Johnson, Clay, Clinton, Ray, Carroll and other adjacent counties oil or gas or both have been found. The wells are all shallow ranging from 100 to 600 feet in depth and the productive horizons are found in the "Lower Coal Measures." The Coal Measures underlie an extensive area in western and northern Missouri, have a maximum thickness of 1650 feet and are largely undrilled. Future investigation may lead to the discovery of new localities in the Coal Measures area favorable for further testing.

Some gas has also been encountered in wells drilled over a limited area in the city of St. Louis. This gas is obtained from the Trenton formation which is encountered at from 600 to 700 feet in depth.

ONYX.

Many of the the large caves which occur throughout the Ozark region contain deposits of onyx.

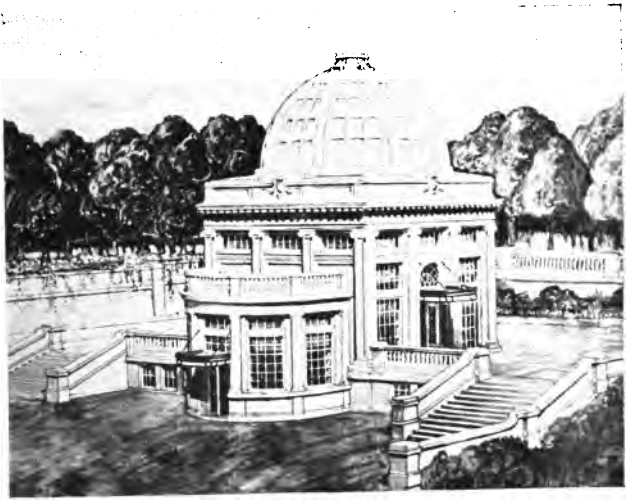
The industry is entirely undeveloped although large blocks of pure and tinted onyx can be obtained. In a Cave in Camden County west of Linn Creek one pillar of onyx has a diameter of 45 feet and a height of 40 feet. This occurrence indicates the size of some of these cave deposits.

PORTLAND CEMENT.

Production in 1916 was 5,732,001 barrels, valued at $6,333,567.

Missouri stands fourth among the states in the production of Portland cement. There are five plants in operation, two in St. Louis, one near Hannibal, one at Cape Girardeau, and one at Cement City in Jackson County. The various plants have a combined daily capacity of about 20,000 barrels.

The manufacture of a high grade Portland cement requires comparatively pure limestone



Siloam Spring Pavilion, Excelsior Springs, Clay County.

Portland Cement Plant, Cement City, Jackson County.

and shale free from large amounts of magnesia. Most of the shale deposits of the state and the limestones of the Coal Measures, Mississippian, Devonian and Ordovician formations are excellent cement making material. The Coal Measures consisting chiefly of alternating limestone and shale formations underlies the northern and western portions of the state. The Mississippian formations are made up chiefly of pure limestone. They outcrop largely in the southwest, northeast and eastern edge of the state. The Ordovician and Devonian formations occupy a narrow belt bordering the eastern edge of the state from Marion to Cape Girardeau counties. A large part of the Ozark region and the lowlands of southeast Missouri do not contain the proper materials for utilization in this industry.

PYRITES.

Pyrites or the sulphide of iron when pure contains more than 50 per cent sulphur which can be separated from the iron by roasting and utilized in the manufacture of sulphuric acid. The greatly increased demand for this acid in the past few years has caused an energetic search for pyrites and a number of deposits have been opened in Missouri since 1914. The output is growing steadily and the industry promises to be a most important one.

The mineral is found chiefly associated with the red iron ores of the central Ozark region where it usually occurs beneath the iron in comparatively thick, high grade deposits. A second type of deposit is being opened near Cornwall, Madison County, where drilling is reported to have encountered from 8 to 40 feet of pyrite. The complex sulphide ores of the Fredericktown district run high in sulphur and could be used in the manufacture of acid.

SAND AND GRAVEL.

Production in 1916 was valued at $877,634.

Missouri and Mississippi rivers, with their many tributaries, supply an inexhaustible source of sand and gravel for building purposes. Active sand pumping plants are located at Canton, Hannibal, Louisiana, St. Louis, Crystal City and Cape Girardeau on the Mississippi, and Jefferson City, St. Joseph, Kansas City, Lexington, Glasgow, Boonville and St. Charles on the Missouri. The Meramec

Quarrying Rock for Portland Cement, Cement City, Jackson County.

Sand Plant on Missouri River, Kansas City, Missouri.

Gasconade, Osage, Black and Elk rivers, all Ozark streams, furnish an excellent grade of gravel to dredging plants at Valley Park, Sherman, Drake, Pacific, Osage City, Poplar Bluff, Mill Springs and Noel. Many other plants operate at scattered points over the state on stream deposits. Bank sands and gravels are obtained at Commerce, Pacific, Maryville, Guilford and elsewhere.

One of the most important mineral industries of the state is the production of glass sand used chiefly for the manufacture of fine plate glass. The sand is obtained exclusively from the St. Peter sandstone, which varies from 50 to 125 feet in thickness and outcrops in a comparatively narrow belt from Callaway County to Cape Girardeau County. It is quarried extensively at Pacific, Crystal City, Festus, Silica, Klondike and good quarry cites are available at many other localities. No finer glass sand is known. A very small part of the quarry product is also used for moulding sand.

SANDSTONE.

Production in 1916 was valued at $14,991.

Sandstone suitable for building purposes has been quarried extensively near Warrensburg, Johnson County; DeWitt, Carroll County, and Ste. Genevieve, Ste. Genevieve County. Local quarries have been operated at many other points in south Missouri especially in Dade, Bates, Barton, Vernon and Cape Girardeau Counties. At Liberal, Barton County, extensive deposits of asphaltic sandstone occur which have been quarried chiefly for flagging. Asphaltic sandstones also occur in Vernon, Cedar, Lafayette, and other west Missouri counties but they are generally too friable for structural purposes.

The most important quarries in the state located at Warrensburg and DeWitt are opened on what are known as channel sandstones of the Coal Measures. These are deposits of exceptional thickness and contain much excellent stone. The St. Peter sandstone is too loosely cemented to be used for building stone.

SILVER.

Production in 1916 was 129,450 ounces, valued at $85,178.

The silver produced in Missouri is derived thru refining the lead obtained from ores mined in the southeast Missouri lead district. The concentrates

Glass Sand, Pacific, Franklin County.

Sandstone Quarry, Warrensburg, Johnson County.

from this region run about one ounce in silver per ton and only a part of these concentrates are refined.

The galena found at the Einstein Silver Mine about 10 miles west of Fredericktown runs 30 to 40 ounces per ton and is true argentiferous galena. During the past two years this mine has been operated for tungsten and some silver bearing lead ore has been recovered as a by-product.

TRIPOLI.

Production in 1916 was valued at $99,248.

Tripoli is found chiefly in Newton County and is quarried extensively near Seneca and Racine. It consists principally of porous, decomposed flint and occurs as residual boulders and in ledges from 2 to 20 feet in thickness. Similar material occurring as small fragments in clay is found in Perry County where it has been utilized for railroad ballast.

The tripoli of southwest Missouri is used chiefly in the manufacture of filters and polishing powders. The stone stands up well and can be used under a considerable water pressure. The chips from the quarry and waste from making filters are utilized in the manufacture of polishing powders, scouring soaps, abrasives, etc.

TUNGSTEN.

During the past two years Missouri has produced tungsten for the first time in the history of the state. The ore is found at the old Einstein Silver mine, west of Fredericktown, Madison County, in quartz veins which carry silver bearing lead ores. When the mine was formerly operated only the silver bearing ore was recovered, the Hubernite or tungsten mineral being considered as waste and left on the dumps. The quartz veins carrying the ore occur in the granite and have been traced for a distance of two miles. Tungsten concentrates carrying 60 per cent tungstic acid are valued at about $1,000 per ton. It is used chiefly in making high grade steel.

ZINC ORE.

Production in 1916 was 304,070 tons, valued at $24,228,596.

The output of zinc ore in 1916 was the greatest in the history of the state, exceeding any former year by $4,600,000. Almost the entire production comes from the southwest or "Joplin" field which

Sheet Ground Mine, Joplin, Missouri.

Soft Ground Mine, Joplin, Missouri.